14.E: Thermochemistry (Exercises)

13.1: Energy, heat and work

13.2: The First Law of Thermodynamics

13.3: Molecules as energy carriers and converters

13.4: Thermochemistry

13.5: Calorimetry

Q13.5.1

After going through combustion in a bomb calorimeter a sample gives off 5,435 cal. The calorimeter experiences an increase of 4.27°C in its temperature. Using this information, determine the heat capacity of the calorimeter in kJ/°C.

Q13.5.2

Referring to the example given above about the heat of combustion, calculate the temperature change that would occur in the combustion of 1.732 g $C_{12}H_{22}O_{12}$ in a bomb calorimeter that had the heat capacity of 3.87 kJ/°C.

Q13.5.3

Given the following data calculate the heat of combustion in kJ/mol of xylose,$C_5H_{10}O_5$(s), used in a bomb calorimetry experiment: mass of $C_5H_{10}O_5$(s) = 1.250 g, heat capacity of calorimeter = 4.728 kJ/°C, Initial Temperature of the calorimeter = 24.37°C, Final Temperature of calorimeter = 28.29°C.

Q13.5.4

Determine the heat capacity of the bomb calorimeter if 1.714 g of naphthalene, $C_{10}H_8$(s), experiences an 8.44°C increase in temperature after going through combustion. The heat of combustion of naphthalene is -5156 kJ/mol $C_{10}H_8$.

Q13.5.5

What is the heat capacity of the bomb calorimeter if a 1.232 g sample of benzoic acid causes the temperature to increase by 5.14°C? The heat of combustion of benzoic acid is -26.42 kJ/g.

S13.5.1

Use equation **4** to calculate the heat of capacity:

$$q_{calorimeter} = heat\ capicity\ of\ calorimeter\ x\ \Delta T$$

5435 cal = heat capacity of calorimeter x 4.27°C

Heat capacity of calorimeter = (5435 cal/ 4.27°C) x (4.184 J/1 cal) x (1kJ/1000J) = 5.32 kJ/°C

S13.5.2

The temperature should increase since bomb calorimetry releases heat in an exothermic combustion reaction.

Change in Temp = (1.732 g $C_{12}H_{22}O_{11}$) x (1 mol $C_{12}H_{22}O_{11}$/342.3 g $C_{12}H_{22}O_{11}$) x (6.61 x 10^3 kJ/ 1 mol $C_{12}H_{22}O_{11}$) x (1°C/3.87kJ) = 8.64°C

S13.5.3

[(Heat Capacity x Change in Temperature)/mass] =[((4.728 kJ/°C) x(28.29 °C – 24.37 °C))/1.250 g] = 14.8 kJ/g xylose

q_{rxn} = (-14.8 kJ/g xylose) x (150.13 g xylose/ 1 mol xylose) = -2.22x10^3 kJ/mol xylose

S13.5.4

Heat Capacity = [(1.714 g $C_{10}H_8$) x (1 mol $C_{10}H_8$/128.2 g $C_{10}H_8$) x (5.156x10^3 kJ/1 mol $C_{10}H_8$)]/8.44°C = 8.17 kJ/ °C

S13.5.5

Heat Capacity = [(1.232 g benzoic acid) x (26.42 kJ/1 g benzoic acid)]/5.14°C = 6.31 kJ/ °C

13.6: Applications of Thermochemistry